CHEMICAL DATING OF BRONZE COIN BLANKS FROM THE ATHENIAN AGORA[1]

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In the summer of 1953 excavators at the Agora in Athens, Greece, found a mass of small pieces of bronze covered with corrosion products immediately below the ancient ground level just outside the corner of the foundations of a destroyed building that was suspected to have been the ancient mint of Athens. After cleaning, eight of these pieces were seen to be thick round discs, two of the pieces similar imperfect discs, and the remaining piece a short length of rod from which the discs had obviously been cut. Light facets on the edges of the discs and on the side of the piece of rod showed that the original rod had been formed by forging. The diameter of the eight complete discs varied from 12 to 14 mm. and the thickness from 7 to 10 mm., their average thickness being 8 mm. These discs ranged in weight from 5.5 to 7.7 g., the average being 6.5 g. Discs such as these have long been recognized as blanks for the striking of coins, and have been found in similar situations at other sites. For example, 43 bronze discs were found in the ruins of a building thought to have been the ancient Greek mint at Chersonesos Taurika in the Crimea (Thompson, 1954).

TABLE 1

Analysis of coin blank

SAMPLE	CU	AG	AU	SN	PB	FE	NI	ZN	TOTAL
NO.	%	%	%	%	%	%	%	%	%
1	66.70	0.07	trace	7.22	25.46	0.14	0.07	0.12	99.78
2	66.37	0.10	trace	6.95	25.80	0.12	0.07	0.07	99.48

Dr. Homer A. Thompson of the Institute for Advanced Study at Princeton, present director of the Agora excavation project, sent one of the imperfect discs to the senior author for chemical analysis in the hope that this would provide an independent confirmation of the antiquity of the bronze. Results of the analysis by the junior author of two clean samples weighing 1.1624 and 1.2987 g., respectively, are shown in table 1. These results show that the bronze from which these samples came is undoubtedly ancient. The presence of gold and silver is very indicative of antiquity, and the proportion of nickel is characteristic of ancient Greek bronze, especially ancient Greek coinage bronze. In a series of bronze coins of Athens the senior author and co-workers found an average of 0.05 percent nickel, and for coins of various other localities in Greece an average of 0.06 percent (Caley, 1939). The low summations indicate the presence of undetermined oxygen and perhaps other impurities in higher proportion than would ordinarily be found in modern bronze. The lack of agreement in the summations and in the percentages of copper, tin, and lead for the two carefully performed duplicate analyses are indicative of a greater degree of heterogeneity than would normally exist in modern metal. Also significant are the high percentages of lead coupled

[1]Paper presented at the Sixty-third Annual Meeting of the Ohio Academy of Science, Athens, Ohio, April, 1954.

with moderate percentages of tin. Such proportions are not found in modern bronzes, but are similar to those that have been found in Athenian coinage bronzes of a certain period. This similarity may be seen by comparing the figures in table 1 with those in table 2, which contains a listing in chronological order of

TABLE 2

Percentage of principal metals in certain Athenian bronze coins

No.	Date	Weight Grams	Cu %	Sn %	Pb %
1	III Century B.C.	6.0	89.64	10.40	0.01
2	" " "	7.8	89.54	9.40	0.54
3	II " "	6.5	88.74	11.10	0.22
4	" " "	5.9	86.38	10.56	2.73
5	I " "	5.1	73.16	7.54	18.82
6	" " "	5.2	71.23	6.84	20.38
7	" " "	6.3	70.25	6.29	22.73
8	I–II " A.D.	5.0	68.05	4.45	26.82
9	II " "	5.4	63.23	3.89	32.51
10	II–III " "	5.4	66.05	4.10	29.32
11	III " "	5.0	66.19	3.75	29.18

the percentages of copper, tin, and lead in all Athenian coins weighing at least 5 g. but less than 8 g. that have been analyzed up to now by the senior author and his co-workers. This series is restricted to coins of this range of weight for the sake of brevity and because the coin blanks are within this range. However, inclusion of all coins that have been analyzed would have shown about the same differences and similarities. On the basis of their types or other available information, none of these coins could be dated with any certainty closer than the century in which they were struck.

TABLE 3

Ratio of percentage of lead to percentage of tin

Specimen	Pb/Sn Ratio
Coin No. 1	0.00
Coin No. 2	0.06
Coin No. 3	0.02
Coin No. 4	0.26
Coin of about 88 B.C.	1.75
Coin No. 5	2.50
Coin No. 6	2.98
Coin No. 7	3.61
Coin Blank	3.62
Coin of I Century A.D.	3.88
Coin No. 8	6.03
Coin No. 9	8.36
Coin No. 10	7.15
Coin No. 11	7.78

In view of the systematic chronological changes in the proportions of lead and tin that have been shown to exist in ancient Greek coinage bronze in general (Caley, 1939) and in Athenian coinage bronze in particular, it is possible not only to confirm the antiquity of these coin blanks by chemical analysis but to establish also the approximate date of their manufacture. Of greater chronological

significance than the order of the percentages of lead and tin are the ratios of the percentages of these metals. In table 3 are shown the ratios of the percentages of lead to tin for the coins listed in table 2. Included also in table 3 are ratios for two additional coins, one of which could be dated from its type almost to the year of its coinage and the other definitely within the first century A.D. These coins are included because they furnish needed fixed points on the time scale, even though their weights fall outside the range of the weights of the blanks. The ratio shown for the blank that was analyzed is an average figure, the individual ratios for the two analyses being 3.53 and 3.71 respectively. It seems significant that the weight of Coin No. 7 is very close to the average weight of these blanks and that the ratio for this coin is almost identical with the average ratio for the blank that was analyzed. This suggests that these blanks may have been intended for coins of this type. At least, from the information at present available, it is the only type of coin that could have struck from these blanks. From the position of the average ratio and the individual ratios for the blank in this series it appears evident that these coin blanks were made in the latter part of the first century B.C., and it seems probable that the date 25 B.C. would not be in error by more than 25 years either way. This suggested date falls well within the broad general period indicated by the archaeological observations, and indeed serves to fix the time at which these coin blanks were discarded, hidden, or lost more precisely than is possible from these observations.

As far as the authors are aware, this is the first attempt to date ancient coin blanks from internal evidence. The success of this attempt suggests the possibility of dating by this same method ancient coins that are illegible because of wear or corrosion. Since coin blanks are rare and illegible coins abundant, the dating of such coins should be the more frequent application of this method of chemical dating in the future.

LITERATURE CITED

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